meter readings; taking samples of wastewater and sludge; and performing simple maintenance and repair work on pumps, electric motors, valves, and other plant equipment. Larger treatment plants generally combine this on-the-job training with formal classroom or self-paced study programs.

In 49 States, operators must pass an examination to certify that they are capable of overseeing wastewater treatment plant operations. A voluntary certification program is in effect in the remaining State. There are different levels of certification depending on the operator's experience and training. Higher certification levels qualify the operator for a wider variety of treatment processes. Certification requirements vary by State and by size of treatment plants. Although relocation may mean having to become certified in a new location, many States accept other States' certifications.

Presently a nationally mandated certification program for operators does not exist. However, the Safe Drinking Water Act Amendments of 1996 require that within 2 years the Environmental Protection Agency specify minimum standards for drinking water operator certification, and that States implement those standards within another 2 years.

Most State drinking water and water pollution control agencies offer training courses to improve operators' skills and knowledge. These courses cover principles of treatment processes and process control, laboratory procedures, maintenance, management skills, collection systems, safety, chlorination, sedimentation, biological treatment, sludge treatment and disposal, and flow measurements. Some operators take correspondence courses on subjects related to water and wastewater treatment, and some employers pay part of the tuition for related college courses in science or engineering.

As operators are promoted, they become responsible for more complex treatment processes. Some operators are promoted to plant supervisor or superintendent; others advance by transferring to a larger facility. Postsecondary training in water and wastewater treatment coupled with increasingly responsible experience as an operator may be sufficient to qualify for superintendent of a small plant, where a superintendent also serves as an operator. However, educational requirements are rising as larger, more complex treatment plants are built to meet new drinking water and water pollution control standards. With each promotion, the operator must have greater knowledge of Federal, State, and local regulations. Superintendents of large plants generally need an engineering or science degree.

A few operators get jobs with State drinking water or water pollution control agencies as technicians, who monitor and provide technical assistance to plants throughout the State. Vocational-technical school or community college training generally is preferred for technician jobs. Experienced operators may transfer to related jobs with industrial wastewater treatment plants, water or wastewater treatment equipment and chemical companies, engineering consulting firms, or vocational-technical schools.

Job Outlook

Employment of water and wastewater treatment plant operators is expected to grow as fast as the average for all occupations through the year 2008. Because the number of applicants in this field is normally low, job prospects will be good for qualified applicants.

The increasing population and growth of the economy are expected to increase demand for essential water and wastewater treatment services. As new plants are constructed to meet this demand, employment of water and wastewater treatment plant operators will increase. In addition, some job openings will occur as experienced operators transfer to other occupations or leave the labor force.

Local governments are the largest employers of water and wastewater treatment plant operators. However, industry deregulation has increased reliance on private firms specializing in the operation and management of water and wastewater treatment facilities. As a result, employment in privately owned facilities will grow much faster than the average. Increased pre-treatment activity by manufacturing firms will also create new job opportunities.

Earnings

Median annual earnings of water and liquid waste treatment plant and system operators were $29,660 in 1998. The middle 50 percent earned between $23,210 and $36,680. The lowest 10 percent earned less than $18,500 and the highest 10 percent earned more than $44,710. Median annual earnings of water and liquid waste treatment plant and systems operators in 1997 were $28,700 in local government, except education and hospitals.

In addition to their annual salaries, water and wastewater treatment plant operators usually receive benefits that include health and life insurance, a retirement plan, and educational reimbursement for job-related courses.

Related Occupations

Other workers whose main activity consists of operating a system of machinery to process or produce materials include boiler operators, gas-compressor operators, power plant operators, power reactor operators, stationary engineers, turbine operators, chemical plant and system operators, and petroleum refinery operators.

Sources of Additional Information

For information on employment opportunities, contact State or local water pollution control agencies, State water and wastewater operator associations, State environmental training centers, or local offices of the State employment service.

For information on certification, contact:

☛ Association of Boards of Certification, 208 Fifth St., Ames, IA 50010-6259. Internet: **http://www.abccert.org**

For educational information related to a career as a water treatment plant operator, contact:

☛ American Water Works Association, 6666 West Quincy Ave., Denver, CO 80235.

☛ Water Environment Federation, 601 Wythe St., Alexandria, VA 22314.

Printing Occupations

Bindery Workers

(O*NET 89721, 92525, and 92546)

Significant Points

- Most bindery workers train on the job.
- Opportunities for hand bookbinders are limited because of the small number of establishments that do this highly specialized work.
- Employment of bindery workers is expected to grow more slowly than average, reflecting increasingly productive bindery operations.

Nature of the Work

The process of combining printed sheets into finished products such as books, magazines, catalogs, folders, directories, or product packaging is known as "binding." Binding involves cutting, folding, gathering, gluing, stapling, stitching, trimming, sewing, wrapping, and other finishing operations. Bindery workers operate and maintain the machines that perform these various tasks.

Job duties depend on the kind of material being bound. In firms that do *edition binding*, for example, workers bind books produced in large numbers, or "runs." *Job binding* workers bind books produced in smaller quantities. In firms specializing in *library binding*, workers repair books and provide other specialized binding services to libraries. *Pamphlet binding* workers produce leaflets and folders, and *manifold binding* workers bind business forms such as ledgers and books of sales receipts. *Blankbook binding* workers bind blank pages to produce notebooks, checkbooks, address books, diaries, calendars, and note pads.

Some types of binding and finishing consist of only one step. Preparing leaflets or newspaper inserts, for example, require only folding. Binding of books and magazines, on the other hand, requires a number of steps.

Bookbinders assemble books and magazines from large, flat, printed sheets of paper. Skilled bookbinders operate machines that first fold printed sheets into "signatures," which are groups of pages arranged sequentially. Bookbinders then sew, stitch, or glue the assembled signatures together, shape the book bodies with presses and trimming machines, and reinforce them with glued fabric strips. Covers are created separately, and glued, pasted, or stitched onto the book bodies. The books then undergo a variety of finishing operations, often including wrapping in paper jackets.

A small number of bookbinders work in hand binderies. These highly skilled workers design original or special bindings for limited editions, or restore and rebind rare books. The work requires creativity, knowledge of binding materials, and a thorough background in the history of binding. Hand bookbinding gives individuals the opportunity to work in the greatest variety of jobs.

Bindery workers in small shops may perform many binding tasks, while those in large shops are usually assigned only one or a few operations, such as operating complicated manual or electronic guillotine paper cutters or folding machines. Others specialize in adjusting and preparing equipment, and may perform minor repairs as needed.

Working Conditions

Binderies are often noisy and jobs can be fairly strenuous, requiring considerable lifting, standing, and carrying. They may also require stooping, kneeling, and crouching. Binding often resembles an assembly line where workers perform repetitive tasks.

Employment

In 1998, bindery workers held about 96,000 jobs, including about 6,600 working as skilled bookbinders and approximately 90,000 working as lesser skilled bindery machine operators.

Although large libraries and book publishers employ some bindery workers, the majority of jobs are in commercial printing plants. Another large employer of bindery workers are bindery trade shops, which specialize in providing binding services for printers without binderies or whose printing production exceeds their binding capabilities. Few publishers maintain their own manufacturing facilities, so most contract out the printing and assembly of books to commercial printing plants or bindery trade shops.

Bindery jobs are concentrated near large metropolitan areas such as New York, Chicago, Washington, DC, Los Angeles, Philadelphia, and Dallas.

Most bindery workers train on the job.

Training, Other Qualifications, and Advancement

Most bindery workers learn the craft through on-the-job training. Inexperienced workers are usually assigned simple tasks such as moving paper from cutting machines to folding machines. They learn basic binding skills, including the characteristics of paper and how to cut large sheets of paper into different sizes with the least amount of waste. As workers gain experience, they advance to more difficult tasks and learn to operate one or more pieces of equipment. Usually, it takes one to three months to learn to operate the simpler machines but it can take up to one year to become completely familiar with more complex equipment, such as computerized binding machines.

Formal apprenticeships are not as common as they used to be, but are still offered by some employers. Apprenticeships provide a more structured program that enables workers to acquire the high levels of specialization and skill needed for some bindery jobs. For example, a 4-year apprenticeship is usually necessary to teach workers how to restore rare books and to produce valuable collectors' items.

Employers prefer to hire experienced individuals, but will train workers with some basic knowledge of binding operations. High school students interested in bindery careers should take shop courses or attend a vocational-technical high school. Occupational skill centers, usually operated by labor unions, also provide an introduction to the bindery career. To keep pace with ever-changing technology, retraining will become increasingly important for bindery workers.

Bindery workers need basic mathematics and language skills. Bindery work requires careful attention to detail so accuracy, patience, neatness, and good eyesight are also important. Manual dexterity is essential in order to count, insert, paste, and fold. Mechanical aptitude is needed to operate the newer, more automated equipment. Artistic ability and imagination are necessary for hand bookbinding.

Training in graphic arts can also be an asset. Vocational-technical institutes offer postsecondary programs in the graphic arts, as do some skill updating or retraining programs, and community colleges. Some updating and retraining programs require students to have bindery experience; other programs are available through unions for members. Four-year colleges also offer programs, but their emphasis is on preparing people for careers as graphic artists, educators, or managers in the graphic arts field.

Without additional training, advancement opportunities outside of bindery work are limited. In large binderies, experienced bookbinders may advance to supervisory positions.

Job Outlook

Employment of bindery workers is expected to grow about as fast as the average for all occupations through 2008 as demand for printed material grows, but productivity in bindery operations increases. Most job openings for bindery workers will result from the need to replace experienced workers who change jobs or leave the labor force.

Growth of the printing industry will continue to spur demand for bindery workers by commercial printers. The volume of printed material should grow due to increased marketing of products through catalogs, newspaper inserts, and direct mail advertising. Book publishing is expected to grow slowly. Rising school enrollments and the expanding middle-aged and older population—age groups that do the most leisure reading—will account for most of this growth. At the same time, the growth of product packaging, such as that required for

CD-ROM, videos, and other business and educational products, will contribute to the relative stability of binding services. The packaging of these items typically involves folding, gluing, finishing, and shrink-wrapping.

Binding is becoming increasingly mechanized as computers are attached to or associated with binding equipment. New "in-line" equipment performs a number of operations in sequence, beginning with raw stock and ending with a complete finished product. Technological advances such as automatic tabbers, counters, palletizers, and joggers reduce labor and improve the appearance of the finished product. These improvements are increasingly inducing printing companies to invest in in-house binding and finishing equipment. However, growth in demand for specialized bindery workers who assist skilled bookbinders will be slowed as binding machinery continues to become more efficient.

The small number of establishments that do this highly specialized work limits opportunities for hand bookbinders. Experienced bindery workers will have the best opportunities.

Earnings

Median hourly earnings of bookbinders were $9.95 in 1998. The middle 50 percent earned between $7.65 and $13.94 an hour. The lowest 10 percent earned less than $6.35, and the highest 10 percent earned more than $17.56.

Median hourly earnings of bindery machine and set-up operators were $9.91 in 1998. The middle 50 percent earned between $7.55 and $13.39 an hour. The lowest 10 percent earned less than $6.26, and the highest 10 percent earned more than $17.25. Workers covered by union contracts usually had higher earnings.

Related Occupations

Other workers who set up and operate production machinery include papermaking machine operators, printing press operators, and various precision machine operators.

Sources of Additional Information

Information about apprenticeships and other training opportunities may be obtained from local printing industry associations, local bookbinding shops, local offices of the Graphic Communications International Union, or local offices of the State employment service.

For general information on bindery occupations, write to:

☛ Graphic Communications International Union, 1900 L St. NW., Washington, DC 20036. Internet: **http://www.gciu.org**

For information on careers and training programs in printing and the graphic arts, contact:

☛ Education Council of the Graphic Arts Industry, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org**

☛ PIA—Printing Industries of America, Inc., 100 Daingerfield Rd., Alexandria, VA 22314. Internet: **http://www.printing.org**

☛ The Graphic Arts Technical Foundation, 200 Deer Run Road, Sewickley, PA 15143. Internet: **http://www.gatf.org**

Prepress Workers

(O*NET 89702, 89705, 89706, 89707, 89712, 89713, 89715, 89717, 89718, 89719A, 89719B, 89799B, 92541, and 92545)

Significant Points

- Most workers train on-the-job; some complete formal graphics arts programs or other postsecondary programs in printing technology.
- Increased use of computers in typesetting and page layout has greatly changed the nature of work and may eliminate many prepress jobs.

Nature of the Work

The printing process has three stages—prepress, press, and binding or postpress. Prepress workers prepare material for printing presses. They perform a variety of tasks involved with transforming text and pictures into finished pages and making printing plates of the pages.

Advances in computer software and printing technology continue to change prepress work. Customers, as well as prepress workers, use their computers to produce material that looks like the desired finished product. Customers, using their own computers, increasingly do much of the typesetting and page layout work formerly done by prepress workers. This process, called "desktop publishing," poses new challenges for the printing industry. Instead of receiving simple typed text from customers, prepress workers get the material on a computer disk. Because of this, customers are increasingly likely to have already settled on a format on their own, rather than relying on suggestions from prepress workers. Furthermore, the printing industry is rapidly moving toward complete "digital imaging," by which customers' material received on computer disks is converted directly into printing plates. Other innovations in prepress work are digital color page makeup systems, electronic page layout systems, and off-press color proofing systems.

Typesetting and page layouts have also been affected by technological changes. The old "hot type" method of text composition—which used molten lead to create individual letters, paragraphs, and full pages of text—is nearly extinct. Today, composition work is done with computers and "cold type" technology. Cold type, which is any of a variety of methods creating type without molten lead, has traditionally used "phototypesetting" to ready text and pictures for printing. Although this method has many variations, all use photography to create images on paper. The images are assembled into page format and rephotographed to create film negatives from which the actual printing plates are made. However, newer cold type methods are becoming more common. These automate the photography or make printing plates directly from electronic files.

In one common form of phototypesetting, text is entered into a computer programmed to hyphenate, space, and create columns of text. Typesetters or data entry clerks may do keyboarding of text at the printing establishment or, increasingly, authors do this work before the job is sent out for composition. The coded text is then transferred to a typesetting machine, which uses photography, a cathode-ray tube, or a laser to create an image on typesetting paper or film. Once it has been developed the paper or film is sent to a lithographer who makes the actual printing plate.

Desktop publishing specialists use a keyboard to enter and select the size and style of type, the column width, and appropriate spacing, and to store it in the computer. The computer then displays and arranges columns of type on a screen resembling a television screen. An entire newspaper, catalog, or book page, complete with artwork and graphics, can be made up on the screen exactly as it will appear in print. Operators transmit the pages for production into film and then into plates or directly into plates. *Preflight technicians* edit the work of the desktop publishing specialists and ensure the overall quality of the finished product before it is delivered to the customer. In small shops, *job printers* may be responsible for composition and page layout, reading proofs for errors and clarity, correcting mistakes, and printing.

New technologies also affect the roles of other composition workers. Improvements in desktop publishing software allow customers to do more of their own typesetting. "Imagesetters" read text from computer memory and then "beam" it directly onto film, paper, or plates, bypassing the slower photographic process traditionally used.

With traditional photographic processes, the material is arranged and typeset, and then passed on to workers who further prepare it for the presses. *Camera operators* are usually classified as line camera operators, halftone operators, or color separation photographers. Line camera operators start the process of making a lithographic plate by photographing and developing film negatives or positives of the material to be printed. They adjust light and expose film for a specified length of time, and then develop film in a series of chemical baths. They may load exposed film in machines that automatically develop and fix the image.